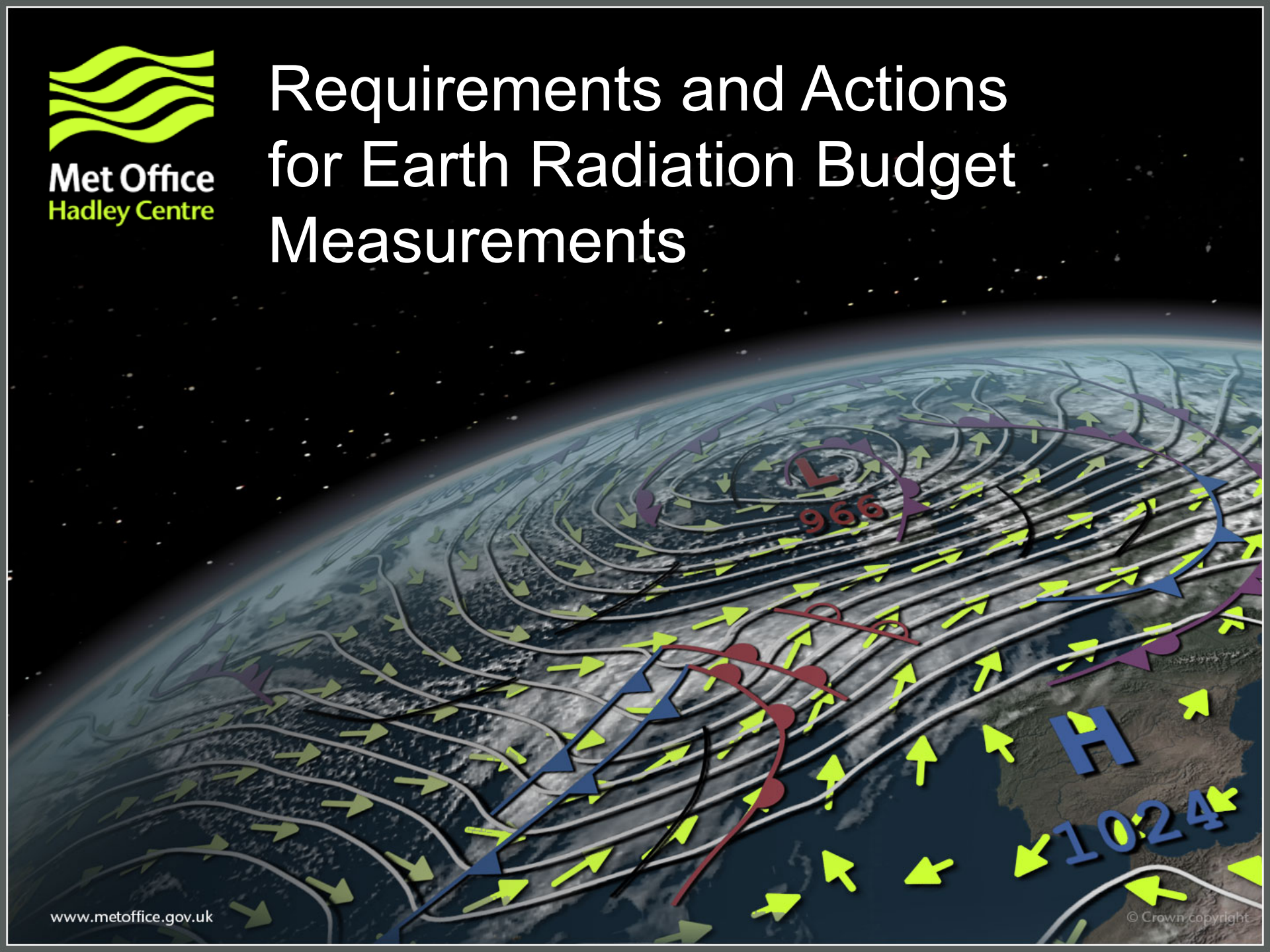
Met Office
Hadley Centre

# Requirements and Actions for Earth Radiation Budget Measurements

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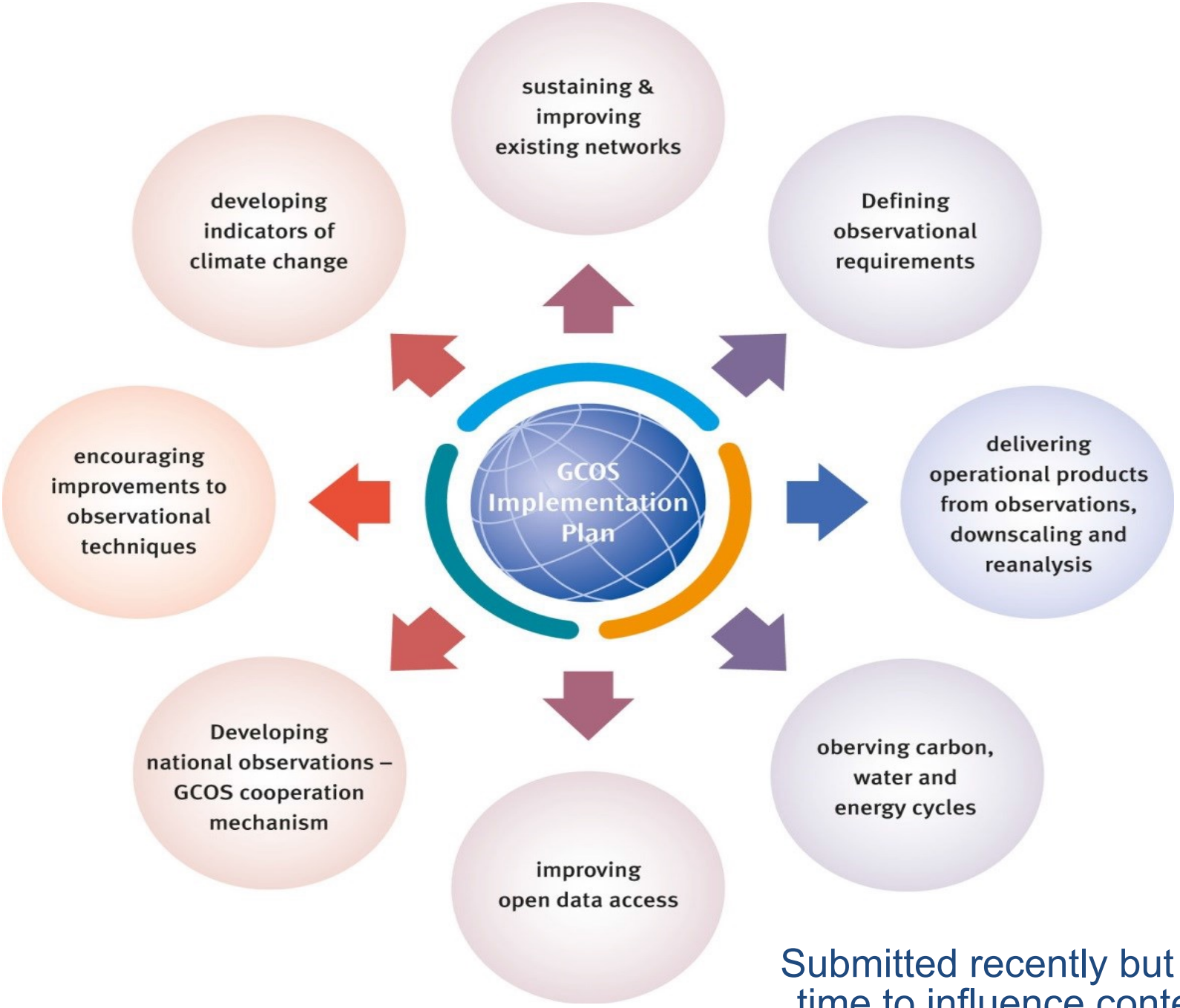



Submitted recently but still time to influence content

# Requirements for radiation budget measurements

- TOA upwelling longwave irradiance
- TOA upwelling shortwave irradiance
- Surface upwelling longwave irradiance
- Surface upwelling shortwave irradiance
- Total solar irradiance
- Solar spectral irradiance

**The requirements need to be reviewed**

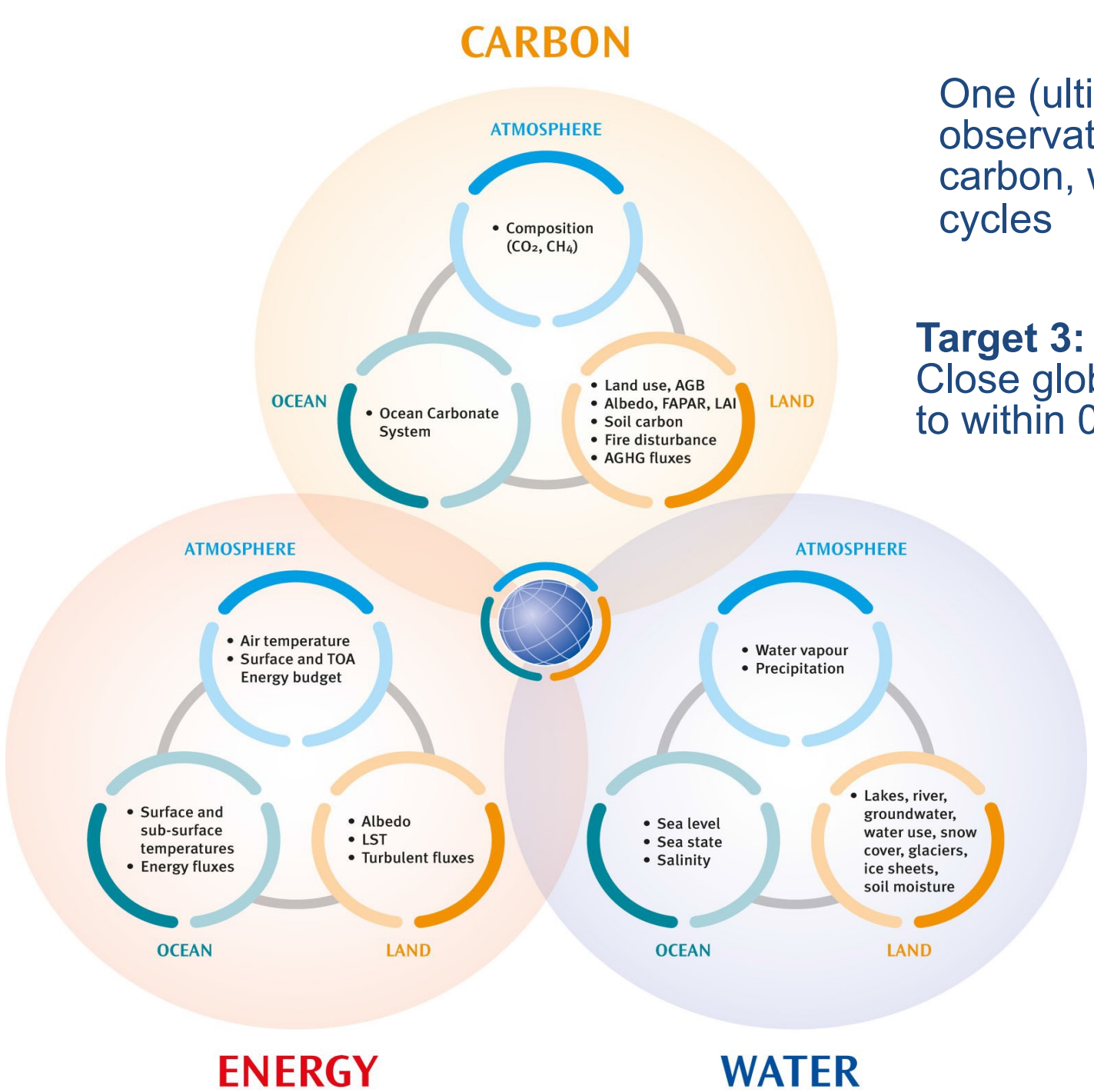
# Requirements

## Latest GCOS definitions in GCOS-IP

| | Variable | Period | H/V Resn | Accuracy | Stability | Source |
|---|---|---|---|---|---|---|
| Earth Radiation Budget | Top-of-atmosphere ERB longwave | Monthly(resolving diurnal cycle) | 100km/NA | Requirements on global mean: 1W/m2 | 0.2 W/m2/decade | NOAA Tech Rep. NESDIS 134 |
| | Top-of-atmosphere ERB shortwave (reflected) | Monthly(resolving diurnal cycle) | 100km/NA | Requirements on global mean: 1.0 W/m2 | 0.3W/m2 /decade | NOAA Tech Rep. NESDIS 134 |
| | Surface ERB longwave | Monthly(resolving diurnal cycle) | 100km/NA | Requirements on global mean: 1W/m2 | 0.2W/m2 /decade | |
| | Surface ERB shortwave | Monthly(resolving diurnal cycle) | 100km/NA | Requirements on global mean: 1W/m2 | 0.2W/m2 /decade | |
| | Total solar irradiance | Daily | NA/NA | 0.035% | 0.01%/decade | |
| | Solar spectral irradiance | Daily | Spectral resolution:<br>1 nm < 290 nm<br>2nm 290-1000 nm<br>5 nm 1000-1600 nm | 0.3%(200-2400nm) | 1%(200-2400nm)/decade | |

1. Do we agree with these requirements?
2. What suggestions do we have regarding the number/orbital characteristics of satellites/instruments that might deliver this?

Note, no clarity on what the underlying priority science questions are!




One (ultimate) goal is to observationally close carbon, water and energy cycles

**Target 3:**
Close global energy budget to within 0.1 W $m^{-2}$.

# Requirements

## WMO OSCAR definitions for various applications

### Requirements defined for *Upward long-wave irradiance at TOA* (5)

This tables shows all related requirements. For more operations/filtering, please consult the full list of Requirements
*Note: In reading the values, goal is marked blue, breakthrough green and threshold orange*

| Id | Variable | Layer | App Area | Uncertainty | Stability / decade | Hor Res | Ver Res | Obs Cyc | Timeliness | Coverage | Conf Level | Val Date | Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 117 | Upward long-wave irradiance at TOA | TOA | Climate-AOPC | 5 W/m$^2$<br>6.5 W/m$^2$<br>10 W/m$^2$ | | 100 km<br>200 km<br>500 km | | 3 h<br>4 h<br>6 h | 3 h<br>6 h<br>24 h | Global | firm | 2007-07-19 | AOPC |
| 307 | Upward long-wave irradiance at TOA | TOA | Global NWP | 5 W/m$^2$<br>10 W/m$^2$<br>20 W/m$^2$ | | 10 km<br>30 km<br>100 km | | 60 min<br>3 h<br>12 h | 24 h<br>5 d<br>30 d | Global | firm | 2009-02-10 | John Eyre |
| 382 | Upward long-wave irradiance at TOA | TOA | High Res NWP | 5 W/m$^2$<br>10 W/m$^2$<br>20 W/m$^2$ | | 2 km<br>10 km<br>50 km | | 30 min<br>60 min<br>6 h | 60 min<br>3 h<br>12 h | Global | firm | 2011-08-04 | T Montmerle |
| 409 | Upward long-wave irradiance at TOA | TOA | Hydrology | 5 W/m$^2$<br>8 W/m$^2$<br>20 W/m$^2$ | | 10 km<br>21.5 km<br>100 km | | 60 min<br>2 h<br>12 h | 24 h<br>46 h<br>7 d | Global | reasonable | 2003-10-20 | ET ODRRGOS |
| 633 | Upward long-wave irradiance at TOA | TOA | SPARC | 5 W/m$^2$<br>7 W/m$^2$<br>10 W/m$^2$ | | 50 km<br>100 km<br>250 km | | 3 h<br>4 h<br>6 h | 30 d<br>45 d<br>90 d | Global | reasonable | 1998-10-29 | WCRP |

Acronyms:
AOPC: Atmospheric Observations Panel for Climate
SPARC: Stratospheric Processes and their role in climate
ET CORRGOS: Expert Team for Observational Data Requirements and Redesign of the Global Observing System

# Requirements

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| 116 | Upward short-wave irradiance at TOA | TOA | Climate-AOPC | 5 W/m$^2$<br>6.5 W/m$^2$<br>10 W/m$^2$ | | 100 km<br>200 km<br>500 km | | 3 h<br>4 h<br>6 h | 3 h<br>6 h<br>24 h | Global | firm | 2007-07-19 | AOPC |
| 305 | Upward short-wave irradiance at TOA | TOA | Global NWP | 5 W/m$^2$<br>10 W/m$^2$<br>20 W/m$^2$ | | 10 km<br>30 km<br>100 km | | 60 min<br>3 h<br>12 h | 24 h<br>5 d<br>30 d | Global | firm | 2009-02-10 | John Eyre |
| 381 | Upward short-wave irradiance at TOA | TOA | High Res NWP | 5 W/m$^2$<br>10 W/m$^2$<br>20 W/m$^2$ | | 2 km<br>10 km<br>50 km | | 30 min<br>60 min<br>6 h | 60 min<br>3 h<br>12 h | Global | firm | 2011-08-04 | T Montmerle |
| 408 | Upward short-wave irradiance at TOA | TOA | Hydrology | 5 W/m$^2$<br>8 W/m$^2$<br>20 W/m$^2$ | | 0.1 km<br>1.26 km<br>200 km | | 60 min<br>108 min<br>6 h | 24 h<br>46 h<br>7 d | Global | reasonable | 2003-10-20 | ET ODRRGOS |
| 632 | Upward short-wave irradiance at TOA | TOA | SPARC | 5 W/m$^2$<br>7 W/m$^2$<br>10 W/m$^2$ | | 50 km<br>100 km<br>250 km | | 3 h<br>4 h<br>6 h | 30 d<br>45 d<br>90 d | Global | reasonable | 1998-10-29 | WCRP |

# GCOS Actions for radiation budget measurements

- Improve surface reporting
- Add sunshine reports
- BSRN enhancements
- Satellite continuity
- Start profile measurements


**They will be reviewed annually**

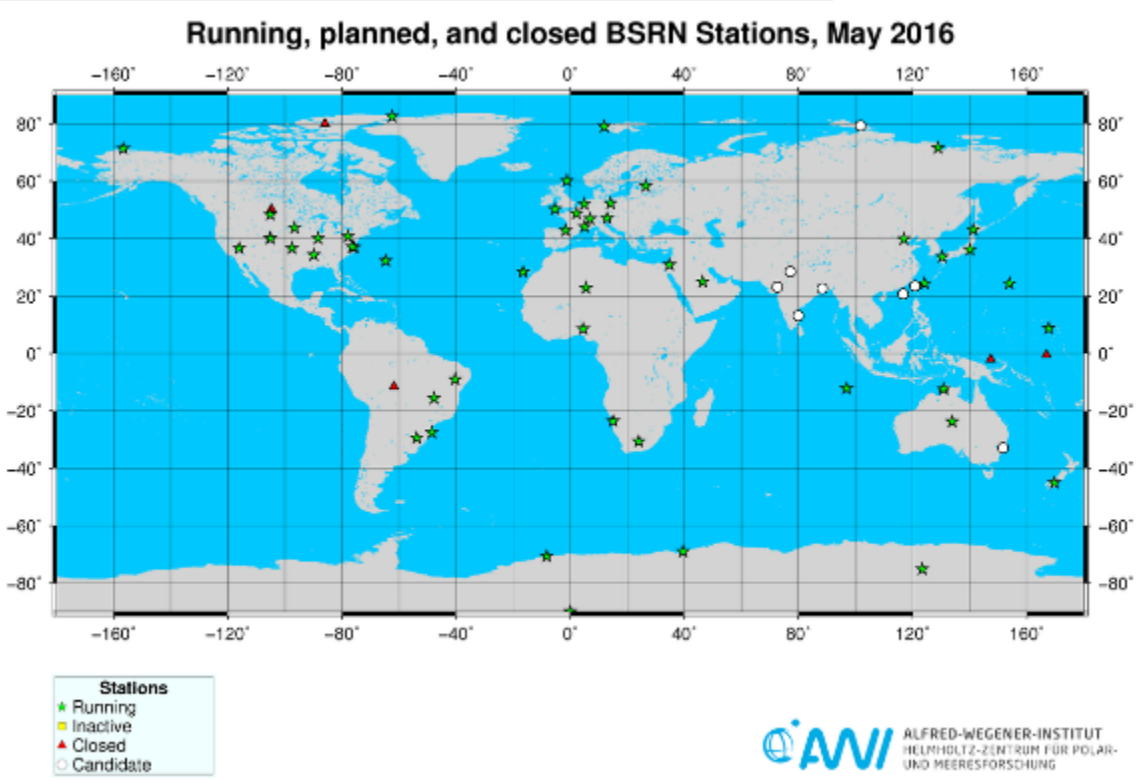
# Surface radiation New actions

| Action | National sunshine records should be incorporated into International Data Centres. |
|---|---|
| Benefit | Better description of surface radiation fields. |
| Who | National Meteorological Services. |
| Time-frame | Implement in next 2 years. |
| Performance Indicator | Sunshine record archive established in International data centres in analysis centres by 2018. |
| Annual Cost | 1-10M US$ |

# GCOS Actions: Surface radiation

| | |
|---|---|
| **Action** | **Ensure continued long-term operation of the BSRN and expand the network to obtain globally more representative coverage and improve communications between station operators and the archive centre.** |
| **Benefit** | Continuing baseline surface radiation climate record at BSRN sites. |
| **Who** | Parties' national services and research programmes operating BSRN sites in cooperation with AOPC and the WCRP GEWEX Radiation Panel. |
| **Time-frame** | Ongoing. |
| **Performance Indicator** | The number of BSRN stations regularly submitting valid data to International Data Centres. |
| **Annual Cost** | 100k - 1M US$ |

Concern over poor coverage. 12 stations no data since 2012.



# GCOS Actions: Surface radiation

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|---|---|
| **Action** | **Submit surface radiation data with quality indicators from national networks to the World Radiation Data Centre (WRDC). Expand deployment of surface radiation measurements over ocean.** |
| **Benefit** | Expand central archive. Data crucial to constrain global radiation budgets and for satellite product validation. More data over ocean would fill an existing gap. |
| **Who** | National Meteorological Services and others, in collaboration with the WRDC. |
| **Time-frame** | Ongoing. |
| **Performance Indicator** | Data availability in WRDC. |
| **Annual Cost** | 1-10M US$ |

# GCOS Actions: Earth Radn Budget
# Vertical Profile Measurements

| | |
|---|---|
| **Action** | **To understand the vertical profile of radiation requires development and deployment of technologies to measure in-situ profiles.** |
| **Benefit** | Understanding of 3D radiation field, model validation, better understanding of radiosondes. |
| **Who** | NMSs, NMIs, HMEI. |
| **Time-frame** | Ongoing. |
| **Performance Indicator** | Data availability in NMS archives.. |
| **Annual Cost** | 1-10M US$ |

# Earth Radiation Budget

| Action | Ensure sustained incident total and spectral solar irradiances and Earth Radiation Budget observations, with at least one dedicated satellite instrument operating at any one time. |
|---|---|
| Benefit | Seasonal forecasting, reanalyses, model validation. |
| Who | Space agencies. |
| Time-frame | Ongoing. |
| Performance Indicator | Long-term data availability at archives. |
| Annual Cost | 30-100M US$ |

There are potential gaps in satellite record and measurements of spectral solar irradiance required for seasonal forecasts is not assured.